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Original Article

Smoking and caesarean deliveries: major negative predictors for breastfeeding in the mother–child cohort in Crete, Greece (Rhea study)

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Abstract

Although benefits of breastfeeding have been widely promoted and accepted, exclusive breastfeeding for the first 6 months of life is far from the norm in many countries. In a prospective mother–child cohort study in Crete, Greece ('Rhea' study), we assessed the frequency of breastfeeding and its socio-demographic predictors. Information on breastfeeding was available for a period of 18 months post-partum for a cohort of 1181 mothers and their 1208 infants. The frequency of exclusive and predominant breastfeeding in the first month post-partum was 17.8% and 3.4%, respectively, with almost three-quarters of women (73.6%) ceasing any breastfeeding after 4 months post-partum. Women were less likely to initiate breastfeeding if they had a caesarean delivery (CD), whereas they were more likely to initiate breastfeeding if they had a higher education or gave birth to a private clinic. Among women breastfeeding, those who had a CD, were ex-smokers or smokers during pregnancy had a statistically significant shorter duration of breastfeeding, whereas higher education and being on leave from work were associated with a longer duration of breastfeeding. Study findings suggest suboptimal levels of exclusive and any breastfeeding and difficulty maintaining longer breastfeeding duration. CD and smoking are common in Greece and are strong negative predictors for breastfeeding initiation and/or duration, necessitating targeting women at risk early in the prenatal period so as to have a meaningful increase of breastfeeding practices in future cohorts of mothers.

Keywords: breastfeeding, breastfeeding frequency, breastfeeding initiation, breastfeeding duration, breastfeeding predictors, lactation score.

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Introduction

The World Health Organization (WHO) (Kramer & Kakuma 2001) considers exclusive breastfeeding (EBF) for the first 6 months of life to be the optimal method for feeding infants, recommendation that is also supported by the American Academy of Pediatrics (2005). Available data are continually evaluated and the EFSA panel on dietetic products, nutrition and allergies (NDA) [EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA) 2009], after evaluating data from developed countries, supported that EBF provides adequate nutrition for optimal growth and development for the majority of infants, while some infants might need complementary foods together with breastfeeding before the age of 6 months.

The benefits of breastfeeding have been widely promoted and accepted – both for full-term and preterm babies (Landers 2003). Breastfeeding has been associated with protection against infections, reduction of atopic disease, promotion of normal growth in the first year of life, a lower risk for obesity

or glucose intolerance (Akerstrom *et al*. 2007). Low rates of breastfeeding coupled with early cessation have been reported to result in greater expenditure on national health care provision and also increase inequalities in health (Directorate Public Health and Risk Assessment 2004).

EBF for the first 6 months of life is far from the norm in many countries (Dykes & Flacking 2010). Data on breastfeeding initiation in Greece have consistently shown that there is a high frequency of any breastfeeding accompanied by a lower frequency of EBF (Bakoula *et al*. 2007b).

Human lactation is influenced by several socio-demographic, biological and psychological factors (Thulier & Mercer 2009). Older maternal age, higher socio-economic status or being a non-smoker has been repeatedly associated with breastfeeding initiation or longer duration (Dennis 2002). Higher levels of education, being married, having other children, delivery at a baby-friendly hospital, paternal support or better infant health are also factors reported to promote a longer duration of breastfeeding (Bakoula *et al*. 2007b).

The objectives of the present study were to assess the frequency of breastfeeding and the socio-demographic predictors associated with breastfeeding initiation, intensity and breastfeeding duration in the 18-month post-partum period (once breastfeeding has been initiated) in a population sample of pregnant women in Crete, Greece, followed from early pregnancy to 18 months post-partum.

Materials and methods

Study sample

The 'Rhea' study is a mother–child cohort study that examines prospectively a population-based cohort of pregnant women and their children, at the prefecture of Heraklion, Crete, Greece. Female residents (Greek and immigrants) who had become pregnant during the 12-month period starting in February 2007 have been contacted and asked to participate in the study. The first contact was made at the time of the first major ultrasound examination, around week 15 of gestation or before. Women were then contacted during the sixth month of pregnancy, at birth, at 8–10 weeks after delivery, and at 6 and 18 months after delivery. Face-to-face structured questionnaires, together with self-administered questionnaires and medical records, were used to obtain the information during pregnancy and early childhood. During the study recruitment period (February 2007–February 2008), 1765 eligible women were approached, of whom 1610 (91%) agreed to participate. A more detailed description of the Rhea study has been published previously (Chatzi *et al*. 2009). The study was approved by the ethical committee of the University Hospital in Heraklion, Crete, Greece, and all participants provided written informed consent after complete description of the study.

There were 1181 women who had available detailed information regarding breastfeeding practices allowing the categorisation of breastfeeding into exclusive, predominant, complementary and no-breastfeeding (NBF) (WHO 1991) during the first 6 months post-partum and additional follow-up information on breastfeeding duration (in months) for 18 months post-partum. Hence, a cohort of 1181 mothers (and their 1208 infants) was available for the present analysis.

These women ($n = 1181$) were compared with women who did not have such detailed information of breastfeeding for 18 months post-partum ($n = 323$) and were not included in the present analysis, but

Key messages

- Study finding suggests suboptimal levels of EBF in Crete with difficulty maintaining longer breastfeeding periods once initiated.
- CD and smoking are strong negative predictors for breastfeeding initiation and/or duration in Crete.
- Targeting women at risk early in the prenatal period seems necessary so as to have a meaningful increase of breastfeeding practices in future cohorts of mothers in Greece and other regions, where CD and smoking are common.

there was available information on birth (type of delivery or gestational age at delivery) and on most socio-demographic or pregnancy/birth outcome variables [i.e. maternal age, maternal education, pre-pregnancy body mass index (BMI), ethnicity, smoking, preterm baby, parity, working status, delivery type, physical activity before pregnancy and type of delivery hospital]. In particular, women included (WI) in the present analysis ($n = 1181$) were older [mean age_{WI}: 29.73, standard $deviation_{WI}$ (SD_{WI}): 4.93] compared with women not included in analysis (WO) (mean age_{WO}: 27.83, $SD_{WO} = 5.54$, $P < 0.01$), had a higher pre-pregnancy BMI [mean $BMI_{WI} = 24.33$ ($SD_{WI} = 4.82$) vs. mean $BMI_{WO} = 23.53$ ($SD_{WI} = 4.65$), $P = 0.012$], were more likely to be Greek ($Greek_{WI}$: 93.85% vs. $Greek_{WO}$: 81.55%, $P < 0.01$), have a higher education (higher $education_{WI} = 30.21\%$ vs. higher $education_{WO} = 16.80\%$, $P < 0.01$), to have given birth in a private clinic (private $clinic_{WI}$:36.66% vs. private $clinic_{WO}$: 26.01%, $P < 0.01$) and reported more frequently exercise before pregnancy ($exercise_{WI}$: 21.85% vs. $exercise_{WO}$: 15.70%, $P = 0.04$).

Breastfeeding

Mothers were asked if they had ever breastfed their child (or placed the child on their breast to feed) in the sixth-month post-partum follow-up questionnaire. It was considered that a woman-initiated breastfeeding is the answer to the previous question that was positive. Reasoning was recorded in case of a negative answer. If the woman had ever breastfed, further information on breastfeeding duration and intensity was asked. Breastfeeding duration (in months) was also updated during the 18th-month post-partum follow-up. Breastfeeding was categorised as exclusive, predominant, complementary and NBF (WHO 1991).

EBF (WHO 1991) requires that the infant receives only breast milk, including expressed breast milk or milk from a wet nurse, and allows the infant to receive drops and syrups (vitamins, minerals and medicines), but does not allow anything else. Predominant breastfeeding (PBF) (WHO 1991) requires that the infant receives breast milk (including milk expressed or from wet nurse) as the predominant source of nourishment, and also allows liquids (water, and water-based drinks, fruit juice and oral rehydration solution), ritual fluids and drops or syrups (vitamins, minerals and medicines). Non-human milk and food-based fluids are forbidden when defining PBF. Complimentary breastfeeding (WHO 1991) requires that the infant receives breast milk, and solid or semi-solid foods allowing liquid and non-human milk intake. Breastfeeding categorisation was done on a monthly basis.

In addition, a lactation score (Krause *et al*. 2010) describing the intensity of breastfeeding was also used, combining duration and exclusivity of breastfeeding for the first 6 months. This score was derived from the detailed monthly feeding data collected at the sixth-month follow-up. A value was assigned for each month – 0 if not breastfed, 1 if complimentary breastfed and 2 if exclusively or predominantly breastfed (fully breastfed). The resulting score has a possible range of 0–12, and possibly more explanatory power than a simple measure of duration (Krause *et al*. 2010).

Potential predictors

Potential predictors of breastfeeding included demographic, socio-economic, lifestyle, pregnancy health-related events and outcomes, which have an established or potential association with breastfeeding in previous studies, composed of maternal age at delivery; ethnic origin (Greek/non-Greek); maternal education [low level: ≤9 years of mandatory schooling, medium level: >9 years of schooling up to attending post-secondary school education (but not attending university or having a technical college degree) and high level: attending university or having a university/technical college degree]; smoking during pregnancy (current smoker/ex-smoker/never smoker); physical activity before pregnancy (yes/no); maternal pre-pregnancy BMI; mother with at least one infant hospitalised in neonatal intensive care unit (ICU), during the first 6 months (yes/no); mother with at least one infant hospitalised (other than in neonatal ICU), during the first 6 months (yes/no); preterm birth (<37 weeks of gestation); marital status (married/other); residential area (urban/rural); type of delivery hospital (prefecture public hospital/

tertiary teaching public hospital/private clinics); mode of delivery (caesarean/vaginal); parity (multipara/primipara); singleton pregnancy (yes/no); maternal employment status (working/working (on leave)/not working); and breastfeeding of a previous infant [defined only for multiparous women (yes/no)].

Statistical analysis

Descriptive statistics were used to summarise the baseline characteristics of participants. Frequency distributions were generated for categorical variables, and means, medians and SDs were computed for continuous variables. The outcome variables of interest were breastfeeding initiation, breastfeeding duration (once breastfeeding was initiated) and lactation score (once breastfeeding was initiated). Bivariate associations between dependent (outcomes) and categorical-independent variables (predictors) were studied using Pearson's chi-square test or Fisher's exact test (when less than five participants were expected in a cell). Bivariate associations between continuous-dependent and categorical-independent variables were studied using either Student's *t*-test (normally distributed continuous variables) or non-parametric statistical methods (Mann–Whitney, Kruskal–Wallis) for non-normally distributed continuous variables. Spearman's rho correlation coefficient was used to estimate the strength of the association between continuous-dependent and continuous-independent variables.

Maternal age at delivery was included *a priori* in all analyses together with those predictors of the outcomes of interest with $P \leq 0.05$ in the univariate analysis (Tables 2,3). The only variable presenting a significant association with breastfeeding (initiation, duration and lactation score), which was not included in the multivariable models, was previous breastfeeding, as if included in the models the sample would be reduced to only the multiparous women. In addition, although the objective of the present study was to explore the associations between socio-demographic characteristics and the probability for breastfeeding, we also included in the analytic models health- and pregnancy-related characteristics so as to minimise confounding by unmeasured clinical predictors.

Multivariable linear and logistic regression models were fit to estimate the longitudinal associations of potential predictors with breastfeeding initiation, duration or lactation score. Estimated associations are described in terms of odds ratios (ORs) with 95% confidence intervals (CIs) (logistic regression models) or β-coefficients and 95% CIs (linear regressions models). Separate models were built for each breastfeeding outcome [breastfeeding initiation, breastfeeding duration in the 18-month post-partum period ($n = 774$), lactation score ($n = 890$)]. All women with available information were included in the analysis having as an outcome breastfeeding initiation. Only women who initiated breastfeeding are included in the analysis having as outcomes breastfeeding duration or lactation score. All hypothesis testing was conducted assuming a 0.05 significance level and a two-sided alternative hypothesis. Data analysis was performed using the statistical software SPSS 19 (SPSS Inc. Chicago IL, USA) and the STATA software, version Intercooled 9.2 (StataCorp. LP, College Station, TX, USA).

Results

Information on breastfeeding was available for a cohort of 1181 mothers and their 1208 infants. Four hundred twenty-three infants started EBF and 452 started breastfeeding and also received supplemental formula during their first 2 days of life. The majority of women (80%; $n = 945$) initiated breastfeeding the first 4 days post-partum, while almost 18% of the women ($n = 209$) never initiated breastfeeding. Approximately 29% of infants ($n = 348$, 29.4%) fully breastfed (exclusive and predominant breastfeeding) the first week, which proportion increased in the second week to almost 39% ($n = 459$) and dropped to 33% ($n = 392$) in the fourth-week post-partum.

A little more than one in five women (21.2%) fully breastfed (sum of exclusive and predominant breastfeeding) during the first month (Table 1). The highest percentage of EBF by women was reported for the first month (17.8%), dropping to almost 9% during the fourth month (Table 1) with a little more than one-quarter of mothers (26.4%, $n = 312$) continuing any breastfeeding in the fifth month.

Table 1. Monthly breastfeeding exclusivity in the first 6 months post-partum, Rhea birth cohort, Crete, Greece ($n = 1181$ women)

	First month	Second month	Third month	Fourth month	Fifth month	Sixth month
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
EBF	210 (17.8)	197 (16.7)	153 (13.0)	104 (8.8)	30 (2.5)	3 (0.3)
PBF	40 (3.4)	77 (6.5)	81 (6.9)	57 (4.8)	23 (2.0)	1 (0.1)
CBF	722 (61.1)	414 (35.1)	275 (23.2)	227 (19.2)	259 (21.9)	252 (21.3)
NBF	209 (17.7)	493 (41.7)	672 (56.9)	793 (67.2)	869 (73.6)	925 (78.3)

EBF, exclusive breastfeeding; PBF, predominant breastfeeding; CBF, complementary breastfeeding; NBF, no-breastfeeding.

As presented in Table 2, several factors were significantly associated with the breastfeeding outcomes in the univariate analysis. Among those, highly educated women, primipara, or those giving birth at a private clinic initiated breastfeeding more frequently (Table 2). On the other hand, being a current smoker, having a preterm delivery or a caesarean delivery (CD) was linked with lower frequencies of breastfeeding initiation (Table 2). It is important to note that approximately 52% of women had a CD in this cohort. Among women who initiated breastfeeding, those with a vaginal delivery, a singleton pregnancy, of non-Greek origin, urban residence, or higher maternal education had a longer duration of breastfeeding in the 18-month post-partum period and a higher lactation score (Table 3).

The odds of initiating breastfeeding were decreased by almost 50% in women who had a CD compared with those with a vaginal delivery after controlling for other possible predictors (Table 4). In addition, the odds of initiating breastfeeding in mothers who had a higher education or gave birth at a private hospital were approximately twice the odds of women with lower education or those giving birth to the prefecture public hospital, respectively (Table 4), simultaneously adjusting for all other possible predictors.

Among women who initiated breastfeeding, those who had a CD, were ex-smokers or smokers sometime during pregnancy had a statistically significant shorter duration of breastfeeding, whereas those with a higher education and being on leave (from work) had a statistically significant longer duration of breastfeeding, simultaneously adjusting for all other possible predictors (Table 4). Similar associations were estimated between the potential predictors and the lactation score for the first 6 months (Table 4).

Discussion

Breastfeeding is a complicated decision and practice with its duration influenced by several socio-demographic, physical and psychological factors (Thulier & Mercer 2009). In the present study population, the frequency and duration of EBF is quite low compared with WHO recommendations and several socio-demographic factors have a statistically significant association with initiation, duration or intensity of breastfeeding. To our knowledge, this is the first cohort study in Greece where pregnant women are followed up from early pregnancy to 18 months post-partum, allowing for prospective assessment of potential breastfeeding predictors during pregnancy as well as the post-partum period.

Data on breastfeeding initiation in Greece have consistently shown that there is a high frequency of any breastfeeding accompanied by a lower frequency of EBF (Bakoula *et al*. 2007b). Although the majority of women (82.3%) in the present study initiated breastfeeding, previous studies in Greece have reported a higher percentage of breastfeeding initiation (Pechlivani *et al*. 2005) and also 6 months EBF (Bakoula *et al*. 2007b). The high frequency of breast milk substitute during the first days of life that was recorded in the present study has been documented in previous studies (Theofilogiannakou *et al*. 2006; Godfrey & Meyers 2009) as well. It is of note, however, that the Rhea study population reported a higher overall (any) breastfeeding frequency at month 6 post-partum than did a previous cohort study (Ladomenou *et al*. 2007) of mothers recruited post-partum in the maternity wards of the same city as the present study, but a lower EBF frequency at 6 months.

Table 2. Associations of maternal socio-demographic, pregnancy-related and infants' characteristics with breastfeeding initiation, Rhea birth cohort, Crete, Greece

	Breastfeeding				*P*-value*
	Ever ($n = 972$)		Never ($n = 209$)		
	%	*n*	%	*n*	
Maternal education†					<0.001¶
Low	16.5	153	23.8	48	
Medium	50.3	468	59.4	120	
High	33.2	309	16.8	34	
Parity					0.003¶
Primiparous	43.5	405	32.0	65	
Multiparous	56.5	527	68.0	138	
Previous breastfeeding experience‡					<0.001¶
Yes	95.7	425	65.0	52	
No	4.3	19	35.0	28	
Maternal working status					0.004¶
Working	36.5	352	30.2	61	
Working (on leave)	16.1	155	9.9	20	
Not working	47.5	458	59.9	121	
Physical activity before pregnancy					0.025¶
Yes	23.2	215	16.0	32	
No	76.8	711	84.0	168	
Smoking during pregnancy					<0.001¶
Non-smoker	56.9	527	53.0	107	
Ex-smoker	22.2	206	13.9	28	
Current smoker	20.8	193	33.2	67	
Birth hospital					<0.001¶
Prefecture public	31.2	303	36.4	76	
Tertiary teaching public	28.6	278	43.5	91	
Private	40.2	391	20.1	42	
Singletons					0.008¶
Yes	97.6	949	91.4	191	
No	2.4	23	8.6	18	
Mode of delivery					<0.001¶
Vaginal	50.8	491	34.0	71	
Caesarean	49.2	476	66.0	138	
Preterm: GA<37 weeks					<0.001¶
Yes	11.8	114	27.9	58	
No	88.2	850	72.1	150	
Child gender§					0.409
Boy	50.7	493	47.5	96	
Girl	49.3	479	52.5	106	
Having at least one infant hospitalised (not in neonatal ICU)					0.098
Yes	16.0	151	20.8	41	
No	84.0	795	79.2	156	
Having at least one infant in neonatal ICU					<0.001¶
Yes	14.1	133	31.0	61	
No	85.9	812	69.0	136	
	Mean	SD	Mean	SD	
Maternal age	29.66	4.75	30.01	5.69	0.610
BMI pre-pregnancy	24.06	4.59	25.48	5.83	0.006¶

GA, gestational age; ICU, intensive care unit; SD, standard deviation; BMI, body mass index. *Chi-square or Mann–Whitney test. †Variable classified as: low level: ≤9 years of mandatory schooling, medium level: >9 years of schooling up to attending post-secondary school education (but not attending university or having a technical college degree), high level: attending university or having a university/technical college degree. ‡Only for multiparous women. §Total 1208 infants. ¶$P < 0.05$.

Table 3. Associations of maternal socio-demographic, pregnancy-related and infants' characteristics with breastfeeding duration (in the 18-month post-partum period) and lactation score in women who initiated breastfeeding, univariate analysis, Rhea birth cohort, Crete, Greece

	Breastfeeding duration (months)				Lactation score		
	n	Mean	SD	*P*-value	Mean	SD	*P*-value*
Maternal education				<0.001‡			<0.001‡
Low	153	3.40	3.97		3.50	3.15	
Medium	468	3.60	3.66		3.84	3.13	
High	309	5.13	4.19		5.19	3.41	
Working status				<0.001‡			<0.001‡
Working	352	3.81	3.38		4.13	3.05	
Working (on leave)	155	5.73	4.60		5.48	3.52	
Not working	458	3.63	3.93		3.84	3.28	
Origin				0.044‡			0.084
Non-Greek	58	5.22	4.72		4.93	3.31	
Greek	905	3.97	3.87		4.17	3.28	
Residence				0.009‡			0.054
Urban	641	4.27	3.99		4.39	3.29	
Rural	189	3.62	3.78		4.00	3.40	
Smoking during pregnancy				<0.001‡			<0.001‡
Non-smoker	527	5.01	4.44		4.93	3.49	
Ex-smoker	206	3.09	2.85		3.61	2.90	
Current smoker	193	2.61	2.75		3.02	2.65	
Birth hospital				0.003‡			0.020‡
Prefecture public	303	3.58	3.82		3.90	3.30	
Tertiary teaching public	278	4.49	4.35		4.41	3.34	
Private	391	4.08	3.64		4.34	3.23	
Physical activity before pregnancy				0.041‡			0.032‡
Yes	215	4.61	4.24		4.74	3.52	
No	711	3.94	3.88		4.11	3.23	
Previous breastfeeding (among multiparae)				<0.001‡			0.003‡
Yes	425	4.45	3.83		4.79	3.42	
No	19	2.07	2.14		2.63	2.29	
Preterm: GA<37 weeks				0.002‡			<0.001‡
Yes	114	3.20	3.64		3.26	2.92	
No	850	4.14	3.94		4.33	3.31	
Marital status				0.011‡			0.013‡
Married	822	4.16	3.97		4.33	3.32	
Other	108	3.46	3.94		3.55	3.03	
Delivery type				<0.001‡			<0.001‡
Normal	491	4.49	4.22		4.63	3.38	
Caesarean	476	3.54	3.53		3.74	3.10	
Singleton				0.002‡			0.003‡
Yes	949	4.09	3.95		4.27	3.31	
No	23	1.77	1.30		2.04	1.19	
Having at least one infant hospitalised (not in neonatal ICU)				0.045‡			0.18
Yes	151	3.50	3.58		3.91	3.22	
No	795	4.20	4.01		4.33	3.32	
Having at least one infant in neonatal ICU				0.13			0.07
Yes	133	3.58	3.63		3.68	2.91	
No	812	4.16	4.00		4.34	3.35	

		Correlation coefficient†		Correlation coefficient†	
Maternal age at delivery	1150	0.091	0.002	0.083	0.005
BMI pre-pregnancy	1127	–0.078	0.009	–0.081	0.007

SD, standard deviation; GA, gestational age; ICU, intensive care unit; BMI, body mass index. *Chi-square, Mann–Whitney or Kruskal–Wallis test. †Spearman's rho correlation coefficient. ‡$P < 0.05$.

Table 4. Associations of maternal socio-demographic, pregnancy-related and infants' characteristics with breastfeeding initiation, duration (in the 18-month post-partum period) and Lactation score, Rhea birth cohort, Crete, Greece

	Breastfeeding initiation		Breastfeeding duration		Lactation score	
	n^* = 1032		n^* = 774		n^* = 890	
	OR[‡]	95% CI	β-coefficient[§]	95% CI	β-coefficient[§]	95% CI
Maternal age at delivery	0.98	(0.94, 1.02)	0.05	(–0.01, 0.11)	0.04	(–0.01, 0.08)
Maternal education						
Medium vs. low	0.96	(0.61, 1.49)	0.10	(–0.70, 0.90)	0.24	(–0.35, 0.82)
High vs. low	2.14[†]	(1.18, 3.91)	1.07[†]	(0.16, 1.98)	1.12[†]	(0.45, 1.79)
Maternal origin (Greek vs. non-Greek)	–	–	–1.20	(–2.33, –0.08)	–	–
Residence (urban vs. rural)	–	–	0.52	(–0.13, 1.17)	–	–
Marital status (married vs. other)	–	–	–0.40	(–1.26, 0.45)	–0.60	(–1.25, 0.05)
Working status						
Working (on leave) vs. working	1.15	(0.61, 2.17)	1.43[†]	(0.63, 2.22)	0.91[†]	(0.31, 1.53)
Not working vs. working	0.91	(0.61, 1.35)	–0.003	(–0.61, 0.61)	–0.08	(–0.55, 0.39)
Parity (multiparous vs. primiparous)	0.71	(0.48, 1.04)	–	–	–	–
Delivery hospital						
Teaching tertiary vs. prefecture public	0.77	(0.51, 1.15)	0.57	(–0.14, 1.27)	0.21	(–0.33, 0.75)
Private vs. prefecture public	1.98[†]	(1.22, 3.22)	–0.08	(–0.74, 0.59)	–0.01	(–0.50, 0.51)
Mode of delivery (caesarean vs. vaginal)	0.51[†]	(0.35, 0.73)	–0.80[†]	(–1.36, –0.24)	–0.84[†]	(–1.26, –0.42)
Singleton pregnancy (yes vs. no)	1.71	(0.73, 3.96)	1.71	(–0.24, 3.66)	1.27	(–0.09, 2.64)
Smoking during pregnancy						
Ex-smoker vs. non-smoker	1.56	(0.94, 2.58)	–1.82[†]	(–2.49, –1.16)	–1.16[†]	(–1.67, –0.66)
Current vs. non-smoker	0.71	(0.47, 1.06)	–2.13[†]	(–2.83, –1.42)	–1.54[†]	(–2.07, –1.01)
BMI pre-pregnancy	0.97	(0.94, 1.00)	–0.02	(–0.08, 0.04)	–0.02	(–0.06, 0.03)
Physical activity before pregnancy (yes vs. no)	1.52	(0.93, 2.47)	0.39	(–0.23, 1.02)	0.31	(–0.17, 0.80)
Preterm (yes vs. no)	0.59[†]	(0.35, 0.98)	–0.05	(–0.93, 0.83)	–0.31	(–0.97, 0.35)
Having at least one infant hospitalised in neonatal ICU						
Yes vs. no	0.57[†]	(0.36, 0.98)	–	–	–	–
Having at least one infant hospitalised (not in neonatal ICU)						
Yes vs. no	–	–	–0.27	(–1.00, 0.46)	–	–

OR, odds ratio; CI, confidence interval; ICU, intensive care unit; BMI, body mass index. *Number of observations in the model. [†]$P < 0.05$. [‡]OR and 95% CI obtained using binary logistic regression including all variables simultaneously in the model. [§]β-Coefficient and 95% CI obtained using linear regression including all variables simultaneously in the model.

The low frequency of breastfeeding in later months has been documented in previous studies (Michaelsen 1997; Theofilogiannakou *et al*. 2006) as well, with Greek studies (Antoniou *et al*. 2005) reporting 7.3% still breastfeeding for more than 1 year. During the sixth month, 78.3% of mothers did not breastfeed, a little lower percentage than the one reported for the sixth month 10 years ago in Greece (Bakoula *et al*. 2007b).

Although maternal age has been described as an important positive predictor for EBF at 4 and 6 months post-partum (Lande *et al*. 2003), age was not a significant predictor for either initiation or duration of breastfeeding in the present study. In agreement with the previous research (Lande *et al*. 2003; Papadimitriou *et al*. 2005; Theofilogiannakou *et al*. 2006), maternal higher education was also significantly associated with initiation and longer duration of breastfeeding and a higher lactation score at 6 months in our study. Women of Greek origin reported a significantly shorter duration of breastfeeding compared with women of non-Greek origin, which is in agreement with previous research in Crete (Ladomenou *et al*. 2007) and outside Greece, with differences in either initiation or duration of breastfeeding among different ethnic groups or immigration status (Celi *et al*. 2005; Ladomenou *et al*. 2007; Singh *et al*. 2007). Although in the multivariable analysis origin was estimated to be a significant predictor of breastfeeding duration, it

should be acknowledged that such significance was marginal.

Smokers and ex-smokers during pregnancy had significantly shorter breastfeeding duration once breastfeeding was initiated and a significantly lower lactation score, which is in agreement with previous studies (Horta *et al*. 1997; Ekström *et al*. 2003; Antoniou *et al*. 2005; Scott *et al*. 2006; Bailey & Wright 2011). Smoking has been negatively associated with initiation of breastfeeding (Bailey & Wright 2011), duration of breastfeeding with EBF at 4 and 6 months (Lande *et al*. 2003), and any breastfeeding (Ekström *et al*. 2003). A possibility might be that smokers believe that breast milk could be harmful to their infant, having in mind campaigns on smoking effects and the necessity of its cessation (Bailey & Wright 2011). The discussion, however, regarding breastfeeding and smoking is still ongoing, with much research needed so as to know the exact effects of breastfeeding once the mother is a smoker, although we know that nicotine, one of several components of cigarette smoke, is secreted in human breast milk with the potential to harm infants even with a dose–response effect, without considering adverse effects of other additional chemicals in cigarette smoke (Einarson & Riordan 2009). The American Academy of Pediatrics (Ward *et al*. 2001), placing emphasis on the necessity of increasing the frequency of breastfeeding and awaiting much needed data, has suggested that probably it is best to breastfeed even when smoking than using milk substitutes, as it is probable that breastfeeding and smoking are less detrimental than bottle feeding and smoking to the infant (Ward *et al*. 2001). Of interest are newer data, suggesting (Higgins *et al*. 2010) that smoking cessation could increase breastfeeding duration, having in mind that data are needed for the most appropriate smoking cessation programmes in the antenatal and post-partum periods. In Greece, however, that smoking is quite frequent and 40% of the adults are daily smokers (Vardavas & Kafatos 2007), reflected also by the high frequency of smokers or ex-smokers in the current cohort, health professionals, researchers and policy makers should focus on relevant programmes of smoking prevention or cessation tailored to pregnant women in addition to much needed research on the effects of breastfeeding once the mother is a smoker.

CD has been negatively associated in previous studies with both initiation, time of initiation and maintenance of breastfeeding (Antoniou *et al*. 2005; Theofilogiannakou *et al*. 2006), although a null effect of CD on breastfeeding has been reported as well (De Lathouwer *et al*. 2004). In the present study, women having a CD had a decrease of the odds of initiating breastfeeding by almost 50% and a significantly shorter duration of breastfeeding. In a study population, where CD is almost as common as vaginal delivery, with increasing frequency of CDs over the last decades in Greece (Mossialos *et al*. 2005; Dinas *et al*. 2008; Papaioannou *et al*. 2008), such an association needs to be taken seriously into consideration and proactive efforts to initiate and maintain breastfeeding should be a priority in the maternity wards as well as during the maternal and infant follow-up post-partum.

Working women had a significantly shorter duration of breastfeeding or a lower lactation score compared with working women on leave, which finding is supportive to previous reports estimating a higher probability of earlier weaning among women who return to work earlier (Scott *et al*. 2006; Calonge *et al*. 2008). There was no difference in breastfeeding duration between working or non-working mothers, which is not intuitive, although previous findings among Greek women suggested that working mothers with longer entitlements of leave intended to breastfeed longer than non-working mothers (Bakoula *et al*. 2007b).

Unfortunately, we do not have details on breastfeeding-related hospital practices (Pechlivani *et al*. 2005; Bakoula *et al*. 2007a; Declercq *et al*. 2009; Daglas *et al*. 2010) so as to understand why giving birth at a private hospital would almost double the odds of breastfeeding initiation compared with giving birth at the prefecture public hospital, although no significant difference in breastfeeding duration would follow. A successful breastfeeding experience depends not only on factors related to the mother and the infant but also on the supportive environment (Scott *et al*. 2006), with the necessity of women being supported not only during pregnancy but also

post-partum so as to be able to breastfeed (Calonge *et al*. 2008).

Breastfeeding benefits both to mothers and infants have been documented (Galson 2008; Godfrey & Meyers 2009), with an agreement among experts that EBF should span the first 6 months of life (Kramer & Kakuma 2001; American Academy of Pediatrics 2005), following the babies' progressive development with sitting up and start teething and demanding solids. Although studied less, benefits to the mother, such as a lower risk for certain types of breast cancer, ovarian cancer and type 2 diabetes mellitus, are also known (Ip *et al*. 2007; Meyers 2009).

Together with the benefits for the infants and mothers, additional potential benefits have been reported for the family, the community, the economy and the environment, including potential for decreased annual health care costs, decreased parental employee absenteeism and family income, or less environmental burden and energy demands for breast milk substitutes (American Academy of Pediatrics 2005). Realistically, of course, there would be some expense due to increased lactation consultations, longer office-visit times and costs for breastfeeding equipment such as breast pumps, all of which, however, could be covered by insurance payments (American Academy of Pediatrics 2005).

The strengths of the present study include the population-based, prospective design and the detailed follow-up of pregnant women from the early prenatal period to 18 months post-partum so as to record potential predictors for breastfeeding with detailed monthly information on breastfeeding exclusivity for the first 6 months, a period that is considered crucial for an intensive breastfeeding practice by WHO and experts. In addition, the models were simultaneously adjusted for important socio-demographic factors, as well as health- and pregnancy-related characteristics so as to minimise confounding by unmeasured clinical predictors. On the other hand, the study is not without limitations. The robustness of our findings particularly in relation to other populations is unknown. Some of the associations may be specific to our population or may be an artefact, partly because of the number of tests carried out. We need to consider significant differences in the population studied compared with participants not included in the present analyses when considering generalisability. Because of missing information in predictors included in the analysis, most but not all participants were included in the analysis models, which would be preferable so as to avoid potential biased estimates if the reason for information being missing is related in any way to the breastfeeding practices. In addition, it would be preferable to have more detailed weekly information on breastfeeding exclusivity further than the first month post-partum. In any case, however, we know that maternal recall is considered a valid and reliable estimate of breastfeeding initiation and duration (Li *et al*. 2005).

In conclusion, our findings suggest suboptimal levels of EBF with difficulty maintaining longer breastfeeding periods once initiated. If satisfactory frequency of EBF is to be reached, regardless of the final consensus on its appropriate duration in developed countries, breastfeeding promoting actions need to be taken together with education of health professionals and parents on its importance. Women least likely to breastfeed, characterised with factors not necessarily modifiable such as women having a CD in the present population, need to be identified, informed and supported so as to engage successfully with breastfeeding. In addition, women with modifiable predictors of breastfeeding, such as smokers, need to be actively targeted and motivated by health professionals to alter lifestyle factors that affect or negate their breastfeeding experience. Otherwise, breastfeeding frequency will not increase satisfactorily as these two aforementioned negative predictors for breastfeeding initiation and/or duration are very common in the current study population.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

MV conceived the aims of the present manuscript, supervised and participated in the statistical analysis and interpretation of the results and wrote the initial draft of the manuscript. LC – who was the field study coordinator for the Rhea study – participated in the study conception, design and drafting of the manuscript. EB provided statistical guidance, performed the data analyses and participated in the drafting of the manuscript. EP, MKar and AP participated in the drafting and revised the manuscript critically. AK participated in the study conception, design and drafting of the manuscript. MKog conceived the study, participated in its design and helped to revise the draft critically. All authors contributed substantially to the study and have critically reviewed all sections of the text for important intellectual content.

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